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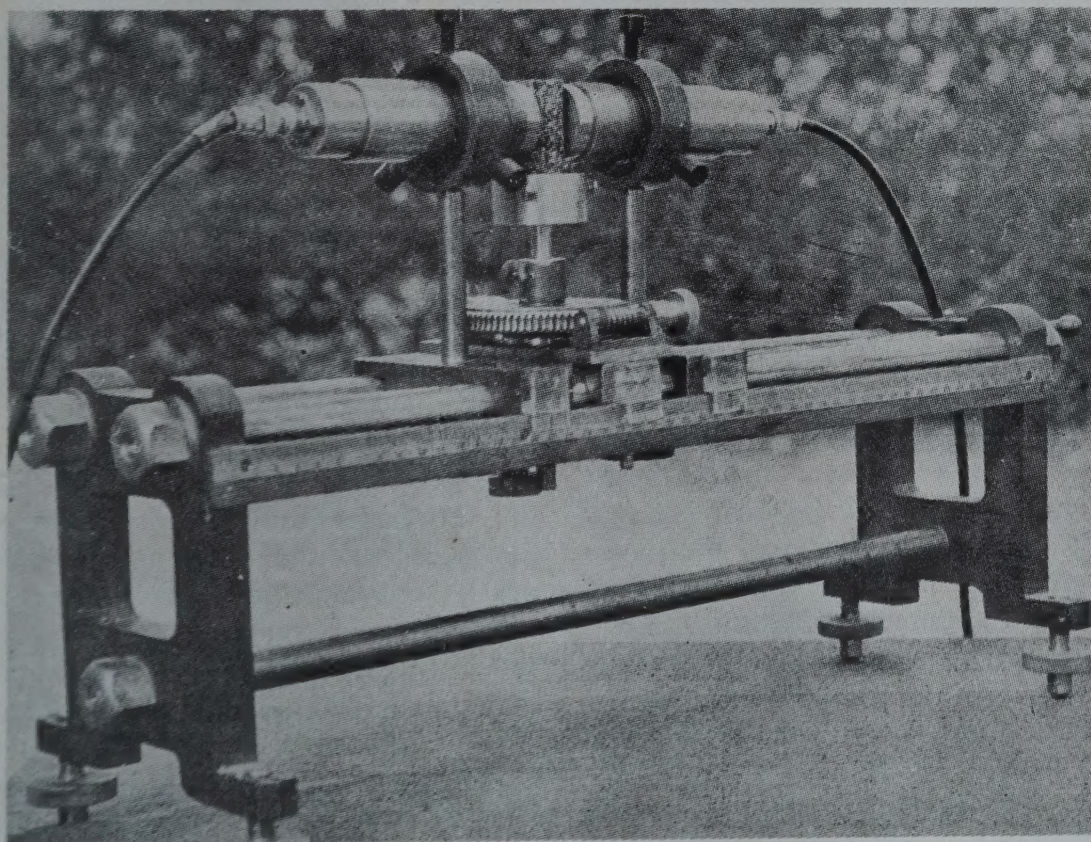
NO. 10

Acoustic Anisotropy Apparatus : NGRI

An apparatus for precise determination of acoustic anisotropy of rock samples and other solid materials has been developed at the National Geophysical Research Institute (NGRI), Hyderabad. The apparatus, designed and developed by Dr Y. V. Ramana, is covered by Indian Pat. 137655. Anisotropic values can be determined within 30 min. and these are needed for studies in the field of geology, geophysics, mining, rock mechanics and material sciences.

The apparatus comprises a levelled mechanical bench on which two acoustic transducers are mounted. The sam-

ple is mounted on a sample holder in between the two transducers with provision for its orientation and rotation. The two transducers can be moved on the bench and their movement can be measured precisely. The apparatus helps in the proper alignment of the transducers in order to obtain the best waveforms in the sample when the electronics is hooked up. With this apparatus, determination of wave velocity and acoustic anisotropy along different directions is possible. Such measurements on rock samples help in picturizing the stress distribution in the sample. With the aid of suitable sample holders the apparatus can be used for the study of different sizes of cylindrical or spherical samples.



Acoustic anisotropy apparatus developed at NGRI

The device incorporates mechanical aids for transducer alignment, and sample rotation with an accuracy of $1/6$ of a degree. The results obtained are repeatable, accurate and precise in comparison with those of the conventional method.

Offshore Surveys by NIO

The National Institute of Oceanography (NIO), Goa, carried out, in March-May 1976, the first survey of submarine pipeline route from Bombay High to Bombay for the Oil & Natural Gas Commission (ONGC). ONGC also requested NIO in December 1976 to carry out a shallow seismic survey in the Bombay High area for designing offshore platforms.

This year ONGC and its consultants, Pipeline Technologist, London, requested NIO for additional surveys for five more possible pipeline routes between Bombay High and Bassein Platform. NIO was also requested by ONGC to carry out a survey of the most suitable place on Angria Bank for jacking up the drilling vessel *Sagar Samrat*.

NIO has completed all these surveys using the research vessel *Gaveshani*. This work of NIO has helped the country in saving several million dollars worth of foreign exchange.

NEERI Reduces Composting Costs

The National Environmental Engineering Research Institute (NEERI), Nagpur, has designed a 200 tonnes per day refuse composting plant at Jaipur. The cost of setting up the plant at Jaipur is Rs 40 lakh, which includes

Rs 17 lakh on machinery and Rs 23 lakh towards civil works. The total cost of constructing a plant of an equal capacity based on other designs is Rs 70 lakh. The design by NEERI has resulted in a net saving of Rs 30 lakh and has thus cut down the cost of composting significantly.

This development of NEERI will be of considerable benefit to civic bodies which are facing a heavy financial burden due to the high cost of solid waste management. It will make available compost, used as a manure, at a much cheaper cost.

TRA's Scientific Committees Meeting

The fifth joint meeting of all the area scientific committees of the tea-growing areas of north-east India was hosted by the South Bank Area Scientific Committee, Area-3 (Nowgong, Jorhat, Golaghat, Sonari and Nazira areas of Assam) and held at Tocklai from 4 to 6 April 1977. Participants at the meeting comprised senior planters of the north and south India, Tea Research Association (TRA), United Planters' Association of South India (UPASI), scientists and technologists, delegates from various agency houses and tea companies in Calcutta, manufacturers of agrochemicals, tea brokers, and local planters.

A souvenir in which planters of the area contributed on their knowledge and experiences in tea-growing under various subjects, such as economics of replanting and extension planting, bringing up of young teas, chemical weed control in mature tea, vegetative propagation, intensive planting, drainage problem, quality control and views on rejuvenation pruning, was released during the meeting. TRA also published a bulletin on soil and climatic conditions of Sibsagar and Nowgong Districts.

The highlights of the first day's demonstrations were unconventional intensive planting with very high density plant population at Mangalam tea estates under Towkok Group,

efficient weed control for increase in crop productivity and progressive ways of raising young teas at Napuk tea estate, and high-yielding clonal plantation by the champion grower of the district at Meleng tea estate. Besides field visits, the first day's programme included visit to Manjushree factory under Towkok Group where some automation in orthodox tea sorting has been introduced.

The second day started with a visit to the instant tea pilot project at Tocklai, recently started under the sponsorship of the Tea Board. The delegates also visited the Gillidhary tea estate located in a rain-shadow pocket of Golaghat area.

From Gillidhary the delegates moved on to Behora tea estate representing the plateau tea areas of Golaghat sub-district. In this tea estate a successful demonstration of Tocklai's concept of catchment planning and contour drainage showed a distinct improvement on the growth and yield of young tea previously said to be suffering from water-logging. The delegates were later taken to the flood plains at Haroocharai tea estate where attempts are being made to utilize marginal land for growing tea in view of the paucity of suitable land for extension.

The last day covered visits to Hunwal Tea Factory, which has the unique distinction for maintaining consistency in the quality of tea produced for the last one hundred years, and Borbhetta Experimental Garden of TRA where several field trials were shown indicating latest knowledge concerning spacing, manuring, shade, infilling, etc. A demonstration on shot hole borer (*Xyleborus fornicatus*), which is a new pest appearing in the area, was given by the Entomology Department of Tocklai Experimental Station.

An open session held on the last day at Jorhat was attended by 250 planters.

The consensus of the forum was that expeditious steps were called for to increase the productivity of teas to bring the beverage within the reach of the common man. In order to achieve

this object the assembly was of the opinion that due care and attention be given to the old teas which still form 75-80% of tea areas.

Some of the stalwarts of tea industry, who went round the district after the lapse of a few years, were of the opinion that the area which was known for long for its low productivity has made a major breakthrough in productivity not only by extension or replanting but by bringing in overall improvement of the old tea too with the introduction of the latest know-how.

The joint Area Scientific Committee meeting ended with an optimistic note to achieve by 2001 AD 1000 million kilogram target fixed at the national seminar on tea held in New Delhi last December.

Information Resources for Environmental Pollution Control : Training Course-cum-Workshop

A four-day training course-cum-workshop on 'Information Resources for Environmental Pollution Control' was organized at the National Environmental Engineering Research Institute, Nagpur, starting from 22 January 1977. The course dealt with the following topics : control of environment—need for an interdisciplinary approach; overall view of the role of information and information service in R & D activities vis-a-vis needs of users of environmental information; a brief overview of sources of information in science and technology with special reference to environmental information; techniques of collection, storage and retrieval of information; environmental information systems and services; environmental data collection and data bank; problems of organization and dissemination of information in the field and the role of National Information Centre on Environmental Engineering; and methods of acquisition, processing and organization of documents related to environmental control.

A colloquium was also arranged during the training course wherein the participants suggested ways and means of improving the information system in the field. Guidelines for setting up an information centre/library in the field were offered.

Seventeen participants consisting of engineers, scientists and documenta- lists attended the course-cum-work- shop.

Training Courses at IIP

In keeping with its basic aim and to meet the requirements of the industry, the Indian Institute of Petroleum (IIP), Dehra Dun, organized a number of short-term, sponsored courses in April 1977.

A training course on 'Quality control of used and re-refined IC engine cranks-case oils' was organized from 4 to 16 April 1977. The objective of the course was to create an awareness of the importance of quality control and the significance of various physico-chemical and performance tests required to qualify an oil up to the desired specification level. The course was organized at the initiative of the Petroleum Re-refiners' Association of India. Eight lube-oil re-refining units of the country deputed their technical representatives. The course covered lube oil, lube oil additives, lube oil deterioration in use and its assessment, motor oil specifications, engine evaluation of motor oils, re-refining of used motor oils and practical quality control on fresh, used and re-refined motor oils.

IIP also organized a one-week special course on 'Application of fuels and lubricants in fleet operation'. The course, organized at the request of Haryana Roadways for their senior engineers, was aimed at a proper training of the roadways engineers to help save substantial amount of valuable oils.

The course covered: refining of crude oils to fuels and lubricants; physical, chemical and performance characteristics of fuels; motor oils,

additives and their specifications; factors affecting fuel economy; exhaust smoke and its significance; gear oils, hydraulic brake fluids; re-refining of used motor oils; greases, their characteristics and application; storage and handling of petroleum products; and air, oil and fuel filtration.

The course was oriented in such a fashion as to enable the Road Transport Corporation engineers to relate the knowledge gained during their training to actual operating conditions encountered in fleet operation.

At the request of the Indian Petrochemicals Corporation Ltd (IPCL), Baroda, IIP organized a four-week training course for IPCL control and analytical chemists. The course is being run in two batches. The first batch underwent training from 20 April to 13 May 1977. The training of the second batch started on 24 May and will be completed on 18 June 1977.

The course covers broadly the specifications of materials/products; quality control in petrochemical industry; standard tests and their significance; instrumental analysis and its requirement; data evaluation and errors in analytical results; qualitative and quantitative analysis; simple theory and practice of gas chromatography, column performance and detector behaviour, optimization of operating behaviour, practical analysis; and elementary theory and practice in IR and UV spectrophotometry.

BITM's Exhibition on Sir Isaac Newton

To commemorate the 250th anniversary of the death of Sir Isaac Newton, a special exhibition was organized at the Birla Industrial & Technological Museum (BITM), Calcutta, from 29 March to 3 April 1977 in collaboration with the British Council, Calcutta. The exhibition depicted the life of Newton and his great contributions to science through 73 photographs, paintings and working exhibits. An illustrated popular lecture on 'Newton's contribution', by Dr Tapen Roy of the Department

of Physics, Jadavpur University, Calcutta, was also arranged.

Deputation Briefs

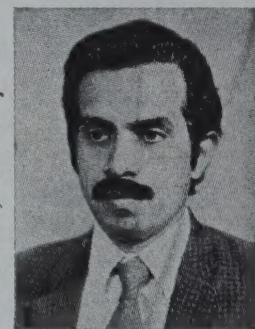
Dr A. K. Basu, Scientist-in-charge, Calcutta Zonal Laboratory of the National Environmental Engineering Research Institute, was deputed by CSIR to participate in the fifth FAO/SIDA workshop at Manila, Philippines, from 17 January to 27 February 1977. The workshop's theme was 'Scientific and administrative basis of management measures needed for aquatic pollution'. Dr Basu delivered two lectures on 'Aquatic pollution versus development' and 'Techniques and purposes of monitoring and other investigations'. Dr Basu's paper on 'Input and interactions of pollutants' was supplied as a background material to the participants who were mostly from the countries of the ESCAP region.

FLUID MECHANICS, GAS DYNAMICS & AIRWORTHINESS OF AIRCRAFT

Bhatnagar Prize-winner
Prof. Narasimha's work

Prof. Narasimha's researches over the last decade have covered a variety of areas in fluid mechanics, and some outside that subject also; but his major interest has been the dynamics of gases at low densities, the structure and behaviour of turbulent flows, and the seemingly unrelated subject of the airworthiness of aircraft, in particular as affected by maintenance and operational procedures.

Satellites and satellite launch vehicles flying at altitudes above 60-70 km



Prof. R. Narasimha

Prof. R. Narasimha of the Indian Institute of Science, Bangalore, has been awarded the Shanti Swarup Bhatnagar prize in engineering sciences for the year 1974 (jointly with Prof. M. A. Pai) [CSIR News, 27 (1977), 57].

encounter unusual fluid-dynamical effects; the mean free path of molecules at these altitudes is comparable to or larger than the dimensions of the vehicle, and the laws of classical fluid mechanics often fail. It becomes necessary therefore to consider explicitly the behaviour of the gas as a collection of molecules not in thermodynamic equilibrium. Narasimha's studies, using extensions of the mathematical technique of singular perturbation theory, have shown elegantly how fast molecules shooting through a shock wave can 'twitch' the gas far ahead of what is normally considered likely in classical fluid mechanics. These ideas have proved useful in studying several different problems. He and his colleagues have also developed computer methods of calculating such gas flows, using what are known as Monte Carlo techniques which simulate a judiciously scaled version of molecular dynamics. Such computer simulations have been used, for example, to estimate aerodynamic characteristics of satellites and launch vehicles at high altitudes.

For a long time it has been thought that most fluid motion tends to be in an unsteady, apparently random state called turbulence. It therefore caused considerable interest when it appeared that under certain conditions a turbulent flow could revert to the laminar state. Much experimental work has been done during the last 10-15 years at the Indian Institute of Science (IISc), Bangalore, among other places, to elucidate the nature of this phenomenon, which incidentally occurs in rocket nozzles, swept-back wings on aircraft, wind tunnel contractions, curved pipes and a host of other situations. The process of such reversion is now beginning to be well understood, largely as a result of work done by Narasimha and his colleagues. He has distinguished between three broad classes of reversion depending on the type of dynamical mechanism responsible. This framework provides a logical basis for resolving many controversies that have surrounded studies of

this phenomenon. This resolution has been achieved by a combination of experimental and theoretical work by his group over the years. The understanding of the phenomenon now acquired could lead to control of turbulence, which would have important technological applications. For example, Narasimha has shown how the design of aircraft aft-bodies can be put on a rational basis using the ideas developed in this and the related work on separated flows.

Another investigation that has thrown considerable light on what may be called the 'memory of turbulent shear flows' involved careful experiment which unambiguously showed the existence of such memory. It was demonstrated here that the stresses at any point in turbulent flow depended not only on the local deformation in the fluid, but on the whole history of the motion.

More recently, Narasimha and his colleagues have studied the nature of the short periods of intense activity, known as 'bursts' that appear to govern the dynamics of turbulent flows. These studies, conducted by using very simple equipment, produced some unexpected results which have far-reaching implications for turbulent flows, not only in technological applications but in a variety of geophysical flows as well. The laws discovered in wind tunnel experiments seem to be equally valid in rivers, oceans and the atmosphere. Narasimha is currently engaged in investigating the relation between such bursts and the weather.

In an entirely different field, he has recently developed methods for analyzing the safety levels inherent in the operation of aircraft in airline service. These methods utilize a computer simulation of an airline fleet, and provide a new and powerful tool for assessing the airworthiness of aircraft in a rational way. The technique also enables one to draw up suitable airworthiness standards in any given phase of flight of an aeroplane. The tools developed here have partly been inspired by his own work in rarefied

gas dynamics, and are in turn helping to understand the behaviour of turbulent flows.

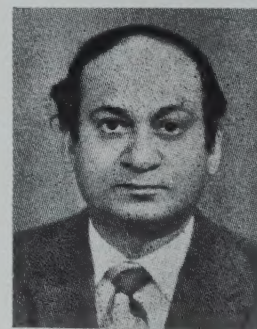
At IISc, Prof. Narasimha leads a distinguished group of scientists that has pioneered in many branches of fluid mechanics: sophisticated measurements in turbulent flow; design and construction of hypersonic facilities in which speeds of up to Mach 8 and 12 and temperatures of several thousand degrees can be generated; design of low-cost windmills; extensive use of computer simulation methods in such diverse fields as rarefied gas-dynamics and aircraft operations in airlines; and use and development of singular perturbation and other mathematical techniques for analyzing fluid flows.

MAGNETISM, SEMICONDUCTIVITY, SUPERCONDUCTIVITY AND EXCITONICS

Bhatnagar Prize-winner

Prof. Sinha's work

Prof. K. P. Sinha's research contributions cover the fields of quantum theory of solid-solid interaction; structural phase transition in solids; mecha-



Prof. K. P. Sinha

nisms of exchange interactions in magnetic crystals; phonon-magnon and electron-magnon interactions and relaxation processes in para-, ferro-, ferri- and antiferromagnetic

solids; electron-phonon interactions and transport properties of semiconductors; origin of giant magnetic moments and resistance minimum phenomenon in dilute alloys; mechanism of superconductivity, in particular, development of the concept of non-equilibrium processes involving

Prof. K. P. Sinha of the Indian Institute of Science, Bangalore, has been awarded the Shanti Swarup Bhatnagar prize in physical sciences for the year 1974 (jointly with Prof. M. S. Sodha) [CSIR News, 27 (1977), 57].

photon-induced superconductivity which shows great promise for getting room-temperature superconductivity; non-radiative electron-hole recombination processes; electronic phase transitions; and exciton condensation.

Having unravelled the mechanism of indirect exchange interaction in magnetic insulators, Sinha and his co-workers studied the interaction between quanta of lattice vibrations (phonons) and spin waves (magnons). Starting from first principles the microscopic mechanisms of phonon-magnon and spin-phonon interactions in para-, ferro-, ferri- and antiferromagnetic crystals were formulated. These formulations which took into account the mixing of excited orbital states owing to various phonon modes as well as the effect of phonons on spins were suggested for the first time for magnetic systems having complex ordering. These had the added advantage of using the sophisticated technique of second quantization and Green's functions. These mechanisms found ready applications in the interpretation of energy transport, relaxation processes and temperature-dependent magnetic resonance linewidth in magnetic insulators. The lead which he gave in this formulation was exploited by research schools in other countries (e.g. USA, Japan) in explaining the hitherto unsolved properties of magnetic crystals. Sinha's work in this field has thus greatly contributed to the understanding of the fundamental mechanisms of the exchange of energy between the spin and the lattice systems and is of lasting value. His work on these aspects of magnetism has had world-wide recognition. Using these mechanisms developed by him in India during this period, he succeeded in settling these questions for the system europium iron garnet and also the temperature-dependent microwave absorption peak in some paramagnets which involves spin-phonon interaction. An expression for spin coupling mediated by transverse optical phonons was derived. This mechanism becomes strong in the

temperature region where the phonon mode of the magnetic solid becomes soft.

In doped magnetic semiconductors (e.g. EuO) the plasmon and magnon energies are comparable and one expects a resonant interaction between these modes of excitations. On the basis of a new microscopic theory formulated for plasmon-magnon interaction, the effects of this interaction on the energies and life-times of these excitations were calculated. The behaviour of a conduction electron in the presence of two Bose fields, namely phonons and magnons, in ferromagnetic semiconductors was studied. In addition to the effects on the energy renormalization there were strong indications of quasi-bound states forming composite entities involving these quasi-particles.

A general expression for the Mössbauer line shape in the presence of radiofrequency field was derived. The distortions and additional transition lines obtained support the experimental data on the relevant Mössbauer nuclear magnetic resonance.

In the spheres of transport properties and giant moments in metals and semiconductors, the phenomenon of resistance minimum in dilute alloys having magnetic element impurity is well known. Sinha and his coworkers demonstrated for the first time that spin-dependent scattering of electrons in semiconductors in conjunction with scattering with phonons led to the resistance minimum phenomenon in such systems. Such effects have indeed been observed in appropriately doped semiconductors.

That resistance minimum phenomenon would show up in alloys having impurities which do not exhibit localized magnetic moments was independently predicted by Sinha and coworkers in India and Kim in USA. These effects are known after their names. These have been confirmed by experimental results on titanium-containing transition element impurities. These involve the subtle effect in which conduction electrons are scattered with

orbital excitation along with spin-flip of impurity electrons.

The occurrence of giant magnetic moment of the order of 12-14 Bohr magnetons in alloys of Fe and Co dissolved in 4d-5d series matrix had been a serious theoretical challenge for some time. These results were successfully explained by Sinha's group by invoking interaction mechanisms which involve both state mixing and exchange interactions. It was demonstrated that hundreds of host atom spins surrounding the impurity get polarized — the results showing remarkable agreements with the data of Geballe *et al.*

It is well known that superconductors with high enough transition temperature (T_c) (e.g. about room temp.) will have tremendous practical applications. In the matter of revolutionary importance this field vies with the fusion reaction. With this end in view, Sinha and coworkers turned their attention to a study of novel mechanisms and conditions for superconductivity. After studying the limitations of one- and two-body electronic interactions and phonon-mediated mechanisms of Bardeen, Cooper and Schrieffer, they considered non-equilibrium mechanisms. This mechanism involves interband and intraband pairing of electrons by the exchange of two bosons (say phonons and photons). Since the strength of the interaction depends on the density of one of the bosons, the mechanism opens up an entirely new direction of approach. The non-equilibrium situation can be realized by maintaining the requisite density of bosons by artificial pumping by lasers or masers. The possibility of photo-induced superconductivity developed by him shows the greatest promise of attaining room temperature superconductivity. Papers on this work have triggered off intensive experimental and theoretical work in USA and USSR.

Excitonics is a field of the future, and processes involving electrons and holes in doped semiconductors and insulators will play a significant role

in solid state applications. At Bell laboratories Sinha studied mechanisms of electron-hole recombination processes and exciton transitions to resolve a long-standing problem connected with doped gallium phosphide. This work had a striking impact on the crash programme of that laboratory. At Bangalore Sinha has initiated the work on exciton tunnelling and exciton condensation to a new phase.

Several solids (e.g. transition metal compounds) exhibit an electronic phase transition wherein they show a conductivity jump of several orders of magnitude as a function of temperature or/and pressure. In some systems there is a sudden volume change without change of crystal symmetry at the transition temperature. Although the nature of the insulating phase seems clear from the work of Mott and Hubbard, the phase transition is by no means well understood. For this purpose a new theory of the insulator

metal transition was developed. The model envisaged involves the existence of two types of electronic states. One is extremely localized (nonconducting) and the other fairly extended (band type). These states are separated by a gap. Initially the localized states are fully occupied while the band-type states that lie above are empty. At a finite temperature some electron-hole pair excitations are thermally produced. Since the electrons are strongly coupled to the lattice, this interaction leads to a 'closing-in' of the surrounding lattice. Thus a positive internal strain is generated which lowers the hole energy parametrically. This favours further electron-hole pair excitation which in turn produces more strain, thus completing the feedback loop. A collapse of the energy gap, which is now a function of such pairs, occurs at a critical temperature. The estimated temperature and volume change are in accord with experimental results.

PROCESSES AND PRODUCTS READY FOR COMMERCIAL UTILIZATION

Cadmium Pigments

The cadmium colours used in plastic and ceramic industries and produced in a range varying from primrose yellow, yellow, orange, red to maroon are a group of pigments based on cadmium sulphoselenides. These pigments are characterized by resistance to high temperature and alkali, stability to light, and non-bleeding nature. They are available both in pure and extended (containing barium sulphate) varieties. These pigments are being imported to the extent of about 25 tonnes, valued at Rs 60 to 70 lakh, per annum.

With a view to lessening the country's dependence on import of these dyes, investigations were carried out at the National Chemical Laboratory, Poona, and a process for the production of cadmium pigments was developed successfully. The process consists

in ball-milling the dry ingredients, calcination at a suitable temperature for getting particular shades, quenching in water, wet grinding, filtration, dry grinding and sieving. The process has been developed on 50 g per batch scale for cadmium red, orange and yellow. Samples, tested by two parties, were found more or less comparable to the imported samples. The samples prepared at the laboratory show heat and light stability. However, they are a little duller and weaker than the imported ones.

The major raw materials required are cadmium carbonate and selenium. Cadmium carbonate is available indigenously while selenium is to be imported. Stainless steel (SS) container, SS balls for ball-milling (three separate sets for each shade), electrically heated furnace for calcination (temperature up to 1000°C), silica tubes for calcina-

tion (three), enamel trays, filtration unit, drier and arrangement for sieving are the major items of plant and equipment. These are either available indigenously or can be fabricated locally.

Since costly raw materials are involved, raw material cost will constitute at least 70% of the finished product; raw material costs per kilogram of red, orange and yellow varieties are Rs 198, Rs 171 and Rs 99 respectively as against the cost of the finished product of about Rs 283, Rs 245 and Rs 140. The prices of the imported product range from Rs 250 to Rs 300 per kg.

Further particulars can be had from: The Managing Director, National Research Development Corporation of India, 61 Ring Road, Lajpat Nagar III, New Delhi 110024.

Portland Cement Coating for Steel

The Central Electrochemical Research Institute (CECRI), Karaikudi, has developed a protective coating based on portland cement which provides good protection to structural steel in a salt-laden atmosphere. The coating provides, in particular, adequate protection to steel reinforcement rods both during storage at site and when embedded in concrete and helps increase the durability of the reinforced concrete structures exposed to aggressive atmospheres. The specific advantage of this coating is that it does not adversely affect the bonding between steel and concrete. Large-scale trial and demonstration has shown that the coating procedure is quite feasible under field conditions.

Besides on reinforcement rods, the coating finds useful and cheap application on steel sheets (corrugated), angles, poles and pipes. Compared to organic coatings, this coating is cheaper.

Portland cement, inhibitor solution and water glass are the main raw materials required for the manufacture

of coating, and all these are available indigenously.

The total investment for setting up a plant capable of producing the coating for protection of 1000 tonnes of steel reinforcement rods is estimated at Rs 80,000 (comprising Rs 30,000 as fixed capital on plant and Rs 50,000 as working capital).

Further particulars can be had from: The Managing Director, National Research Development Corporation of India, 61 Ring Road, Lajpat Nagar III, New Delhi 110024.

Piezoelectric Vibration Pickup (Accelerometer)

Vibration pickup is a device that converts shocks or vibratory motion into an optical, mechanical, or most commonly, electrical signal which is proportional to a parameter of the applied motion.

Accurate measurements of vibration are very essential for locating possible centres of excessive vibration, especially to tackle problems of noise in machines and other structures. Moreover, if vibrations of more than a certain amplitude are allowed to propagate in neighbouring structures over a period of time, they may lead to disastrous consequences.

The Central Electronics Engineering Research Institute, Pilani, has developed two types of piezoelectric vibration pickups: (i) cantilever type, and (ii) axial type. The cantilever type is more sensitive than the axial type but its frequency response is limited. The wide-band accelerometers are generally of axial type. The institute has made twelve piezoelectric pickups of the following specifications and their performance has been found satisfactory.

	<i>Cantilever type</i>	<i>Axial type</i>
Frequency response	: 15 Hz to 1 kHz	15 Hz to 20 kHz
Open circuit sensitivity	: 25 mV/g at 45 Hz	15 mV/g at 100 Hz

The device can be used as a transducer for the measurement of vibration.

The estimated demand for this device is about 5000 units/annum. The main raw materials required are ceramic disc, brass case, rubber discs, M. S. discs, aluminium foil, araldite, screw and connectors. The main equipment required are lathe, grinder, drilling machine and hand tools. All these raw materials and equipment are available indigenously.

The main test instruments required are oscilloscope (up to 300 kHz), vacuum tube voltmeter (100 MHz), multimeter, capacitance bridge (5 pf-1000 mf) and vibration table. All the test instruments except the vibration table are available indigenously.

The techno-economics of the production of the device is as follows: suitable economic production, 1200 units/annum; fixed capital on plant, Rs 1,10,000; working capital, Rs 40,000; and cost of production/unit, Rs 125.

Further particulars can be had from: The Managing Director, National Research Development Corporation of India, 61 Ring Road, Lajpat Nagar III, New Delhi 110024.

Dental Amalgam Alloy

The National Metallurgical Laboratory (NML), Jamshedpur, has developed a process for the production of a dental amalgam alloy which is used for filling up the cavity of decayed teeth.

The estimated demand for this alloy is 4000 to 5000 kg per year and this is met partly by imports.

In the NML process, raw materials in the purest form are melted in a furnace, and the melt is stirred thoroughly before pouring. Pouring is done in mould. The ingot is then homogenized, processed for obtaining proper particle size followed by suitable heat-treatment. All the raw materials required are available indigenously.

The main equipment required are: melting furnace, crucible, ingot moulds, shaping machine, annealing furnace, and cold flat rolling mill. All the equipment, except for cold flat rolling mill, are available indigenously.

Laboratory-scale investigations have been completed. A successful clinical service trial was conducted at the Tata Main Hospital.

The material was tested as per the standard specification and was found to conform fully to IS: 4704-1968, BS: 2938-1957 and to that of the American Dental Association, 1934.

The suggested capacity of an economic unit is 3000 kg of alloy per year. The estimated capital investment for such a plant (based on 2 shift operations in a day and with 300 working days in a year) is Rs 13.35 lakh, and the cost of production per kilogram is about Rs 1400.

Further details can be had from: The Managing Director, National Research Development Corporation of India, 61 Ring Road, Lajpat Nagar III, New Delhi 110024.

PATENTS ACCEPTED

Indian Pat. 1804/Cal/73
(New No. 140298)

Fabrication of metallic honeycombed structures by diffusion welding in a gaseous medium

G. J. Guru Raja*
Central Mechanical Engineering Research Institute, Durgapur

This patent relates to a method of fabricating honeycombed panels by a unique process known as diffusion bonding or welding. Diffusion welding is a joining process in which time, temperature or pressure produces through diffusion the coalescence of materials being bonded. This process consists of two stages: (i) plastic flow of metals leading to intimate contact disrupting the oxide film; and (ii) grain growth across the original interface leading to the establishment of the metallurgical bond.

When two surfaces are brought together the contact is first established at the asperities existing as a result of the surface roughness. The contact area can be increased if the asperities

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are deformed. This deformation can be brought about by applying a load to the surfaces in contact and by raising the temperature of the contact surface. During the deformation of the asperities the oxide layers are broken down and diffusion can start across the boundary if the contact surfaces are held at a definite temperature.

If diffusion welding has to continue uninterruptedly, the oxide layer on the mating surfaces should be broken down and the surfaces should be prevented from repeated oxidation.

While in the earlier well-known processes the aim was to prevent oxidation, in the present process oxidation is allowed to proceed initially but the oxide layer so formed is dissolved in the metal itself.

Most of the metallic oxides formed on the surface of metals do not possess stoichiometric composition, i. e. a metallic oxide contains less metal than its chemical formula indicates. Such an oxide layer possesses a defect structure which promotes migration of metal ions from the interior to the surface and the oxide moves deeper to take the position of those metal ions which have earlier moved to the top when heated. Thus when a metal is heated in a closed space from which air or oxygen can neither enter nor escape, the metal starts oxidizing rapidly. As time progresses, the rate of oxidation decreases as the volume of oxygen available for oxidation continues to decrease. After some time the entire oxygen in the closed space is utilized in oxidizing the metal and further oxidation stops. However, the movement of the metal ions to the outer surface continues even after oxidation has stopped because the metal migration is dependent on the temperature and the defect structure of the oxide lattice. After a certain stage the diffusion of the metal ions through the oxide layer enriches the surface by metal atoms or by an oxide phase rich in metal. If two such surfaces enriched by metal atoms are brought into con-

tact with each other under pressure at high temperature, diffusion will proceed and a metallic bond will be formed. Thus welding can be accomplished. Applying this principle of cleaning of metallic surface by heating the same in an atmosphere rich in oxygen honeycomb panels have been fabricated and tested to ensure that sound metallurgical bonds are produced. The advantages of this method are: (1) high-temperature vacuum is not required for diffusion welding; (2) filler metal is not added, which contributes to the increase in weight of the honeycomb panel; (3) brazing fluxes are not used and hence corrosion to the action of residual brazing fluxes are avoided; and (4) only a high temperature furnace is required for effecting diffusion bonding thus reducing the investment on capital items.

PERSONNEL NEWS

Appointments/Promotions

The following personnel of the Central Electrochemical Research Institute, Karaikudi, have been promoted consequent on five-year assessment with effect from the dates noted against their names: Shri K. S. Srinivasan (as Scientist C; 12 Sep. 1974); Shri K. T. Veeraraghavan (as Scientist C; 12 Sep. 1973); Shri S. Chidambaram (as Scientist C; 31 March 1976); Shri P. V. S. Subramanian (as Scientist C; 31 March 1976); Miss R. Vijayavalli (as Scientist C; 26 July 1976); Dr V. Krishnan (as Scientist C; 11 Aug. 1976); Shri K. K. Janardhanan Pillai (as Scientist B; 19 Aug. 1975); Shri M. Nagalingam (as Scientist B; 29 Sep. 1976); Dr S. Venkatakrishna Iyer (as Scientist B; 7 June 1976); Shri T. M. Balasubramanian (as Scientist B; 12 June 1976); and Shri R. Lakshminarayanan (as Scientist B; 7 Aug. 1976).

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The following personnel have been appointed Scientist B at the Indian Institute of Petroleum (IIP), Dehra Dun: Dr H. B. Goyal (30 April 1977) and Shri V. K. Verma (4 May 1977).

Industrial Information Service

The Publications & Information Directorate (PID), New Delhi, has started an Industrial Information Service (IIS). As a first step of this service, the directorate has started bringing out a bimonthly bulletin, *Industrial News Digest*. The first pilot fascicle of the digest (mimeographed) has been brought out. It provides technical and techno-economic information in three sections, viz. Industry profile, Industrial news [subdivided into general, engineering industry, chemical industry and miscellaneous industry] and Announcements. A feedback card is attached to the digest for studying users' response.

Further plans of IIS include a query-answer service followed by a Selective Dissemination of Information (SDI) service on payment basis.

Indian Scientific and Technical Books 1966-75: Classified Catalogue

The Publications & Information Directorate (PID), New Delhi, has brought out a classified catalogue (mimeographed) of the English titles displayed at the third exhibition of Indian Scientific & Technical Books (1966-75), held at PID from 17 to 20 November 1976 as part of its silver jubilee celebrations. One thousand seven hundred and seventy entries are listed in alphabetic order under appropriate subject headings which in turn are arranged according to their respective class numbers. The catalogue includes, besides the list of titles, a subject index and a list of publishers who participated in the exhibition.

Copies (only a limited number available) of the catalogue can be had from Shri S. Nagarajan, Scientist-in-charge, Library & Reference Section, Publications & Information Directorate, Hillside Road, New Delhi 110 012.